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SHAKES ASSOCIATED WITH WOUNDS IN TREES

by

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ABSTRACT

Dissections of over 4,000 trees immediately after they were felled showed that when shakes occurred, they were associated with wounds. But all wounds did not lead to shakes. Ring shakes were associated with a variety of wounds on trunks, while ray shakes were associated with wounds at or below the root collar. Ring shakes formed most commonly between wood present before wounding and wood formed after wounding. The first cells that formed after wounding were different in many ways from normal cells. These altered cells formed a wall between the cells present at the time of wounding that were subsequently invaded by microorganisms and the healthy, unstained wood cells that continued to form in subsequent growth layers after the wall of altered cells was formed. Most ring shakes occurred on the inner side of the wall.

INTRODUCTION

When shakes were found in trees immediately after they were felled, detailed dissections showed that the shakes were associated with wounds. Shakes are defects that greatly reduce the value of wood for many products. Ring shakes are separations of the wood between and parallel to the growth layers. Ray shakes are radial separations along the rays.

Many different explanations for shakes have been given (Wilson, 1962), but none have been widely accepted. Growth stresses and compression failures (Koehler, 1933), along with traumatic gum veins and resin canals (Boyd, 1950; Jorgensen and Leczner, 1964), have been cited as related to shakes. Anatomical studies (Meyer and Leney, 1968) and studies on the ultrastructure of separating tissues (Kandeel and McGinnes, 1970) have added valuable information on shakes.

Although some investigators have studied shakes in trees soon after they were felled, and although Wangaard (1950) stressed the importance of studies on shakes in living trees, very few investigators have concentrated on shakes as they occur in trees immediately after felling. Most investigators have studied wood collected long after the tree was cut and, many times, after the logs were sawed into boards. It would be difficult to impossible to see from such samples the association of shakes with wounds.

MATERIALS AND METHODS

Since 1960, over 4,000 trees in northeastern United States have been felled and dissected in studies designed to help clarify the processes that result in discoloration and decay in living trees (Shigo and Larson, 1969). Details on materials and methods, and the results of these studies have been published by the author, and only those portions pertinent to shakes are given here. The trees ranged from 10 to 60 cm. diameter at 1.4 m. aboveground and from 25 to 300 years old. The major species studied were Acer rubrum L., A. saccharum Marsh., Betula papyrifera Marsh., B. alleghaniensis Britt., Fagus grandifolia Ehrh., Fraxinus americana L., Quercus rubra L., Q. alba L., and Tsuga canadensis (L.) Carr. Dissections were made with a chainsaw immediately after the trees were felled to determine the association of external signs with columns of discolored and decayed wood. Over 150,000 isolations were made for microorganisms. Histological studies were made of wood in all stages of discoloration and decay. These studies gave information on the successions of microorganisms, the patterns of discoloration and decay, and the changes in tissues after wounding.

When shakes were in felled trees, detailed dissections were made to determine whether some external signs were associated with them. Information on ray shakes came from dissections of trunk, butt, and root sections of 23 mature Q. rubra and Q. alba trees that were excavated. In all species, wood samples were cut from portions of the trunk that were suspects for shake. These samples were observed as they dried in the laboratory.

RESULTS AND DISCUSSION

All shakes were associated with wounds: branch stubs, stem stubs, basal sprout stubs, pruning wounds, dead tops, fire wounds, mechanical wounds, animal wounds, bird pecks, and insect wounds. But all wounds did not lead to shakes. To understand why shakes sometime develop after wounding, an understanding of the events that follow wounding is necessary.

Trees have very effective systems for protection and repair. Although most wounds heal, some do not. In those wounds that heal slowly or do not heal, microorganisms--bacteria and fungi--play an important role in processes that result in discoloration and decay. After wounding, many chemical changes occur in the tissues around the wound that protect the wood from invasion by most microorganisms.

Anatomical changes in tissues occur after wounding as the cambium forms cells different in many ways from those formed normally. The type, orientation, and contents of the cells are different. The vertical and circumferential extent of these changes depends on the severity, number, position, and type of wound. In a sense, the altered cells act as a wall between the tissues present at the time of wounding and those that continue to form in a normal way in subsequent growth layers after the wall is formed. When microorganisms that are able to surmount the chemical barriers infect the wound and invade the wood, they do so only in tissues on the inner side of the wall of altered cells. The tissues that form in subsequent growth layers on the outer side of the wall usually remain free of microorganisms and discoloration and decay.

The wall of altered cells, and the changes in the tissues on the inner side of it, are the keys to understanding shakes. The wall of altered cells forms, to some extent, after all wounds, so the wall by itself is not the sole cause for shakes. Microorganisms that are able to quickly surmount the chemical barriers gain entrance to wood through most wounds that do not heal rapidly. All such wounds do not form shakes; so microorganisms alone do not initiate shakes. But, when ring shakes do occur, they occur most frequently along the inner side of the wall. The number and position of wounds, the action of microorganisms, contraction pressures due to aging and drying, and strain due to wind may all be necessary in the proper combinations before the wood separates.

The time of year of wounding may also be of great importance. If a wound occurs during the dormant season, the wall of altered cells will begin to form at the beginning of the next growing season. If a wound occurs during the growing season, the wall will begin to form immediately. The position of this wall, in the growth ring or at the beginning of the growth ring, may be very important.

In most cases, shakes did not develop in the wood samples until they began to dry. When the shakes did develop they occurred at the inner side of the wall of altered cells.

Shakes may also occur at the discolored wood-decayed wood interface in trees. In most cases, these shakes form as the decayed wood dries and pulls away from the discolored wood boundary. In oaks, these ring shakes developed most commonly at the sapwood-heartwood boundary that was present at the time of wounding.

The impact of felling a tree or of sawing a green log will often cause the shake to extend along the growth ring far beyond the wound. If the shake is observed at a point far from the wound, the association of the wound with the shake will not be recognized. The impact of felling will also cause tearing of tissues along the shake zone.

Dissections of butts and roots of oaks showed that ray shakes were always associated with central pockets of decay that developed as a result of low wounds when the tree was young or of decayed portions of sprout stubs that had been long encased in the dominant stem. Ring shakes still developed first, and ray shakes followed after the decay became advanced in the central core. As the ray shakes developed, microorganisms invaded the newly exposed tissues. Some ray shakes developed outward to the cambium and formed seams.

To understand shakes, studies must start with thorough dissections of trees immediately after they are felled.

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